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ORIGINAL PAPER

Revision total hip arthroplasty using a cementless tapered revision stem in patients with a mean age of 82 years

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Abstract
Purpose A tapered straight cementless stem was used for revision in a group of old and very old patients. We wanted to know whether the use of this implant could achieve satisfactory results despite age and osteoporosis.
Methods We retrospectively analysed data of 77 elderly patients (77 hips) who underwent revision in cemented and uncemented primary total hip arthroplasties (THA). The patients had a mean age of 82.2 years (range, 75–92 years) at revision surgery. They were monitored for a mean follow up of 7.1 years (range, 5.0–10.2 years). During the minimum follow-up period 11 patients died of unrelated causes, leaving 66 patients (66 hips) for evaluation.
Results During the period of study three stems failed due to aseptic loosening, three hips dislocated and were successfully treated by closed reduction and bracing. No infection, osteolysis or significant stress shielding around the stems was observed. The survivorship at an average of 7.1-year follow-up was 95.5%.
Conclusions These results indicate that this stem is an excellent alternative in revision THA in patients of 75 years or older.

Introduction

Revision after failed total hip arthroplasty (THA) resulting from loosening of the femoral component can be challenging even for experienced surgeons [1]. Aseptic loosening is the reason for failure in approximately 70–80% of patients who require THA revision [2]. Surgeons are increasingly using cementless fixation of the femoral stem in revision THA because of relatively high incidence of stem loosening in cemented fixation [1, 3].

Using cementless stems in revision THA requires maximised fitting, immediate press-fit stability, control of axial and rotational stability, and optimal bone remodelling over a long period of time. However, these requirements are not easily met in old patients, especially those with osteoporosis. Additionally bone resorption can be accelerated as a consequence of the loosening process of the implant. Osteoporotic bone is at increased risk for fracture during surgery, especially when the surgeon inserts a rasp or fit-and-fill femoral stem [3].

The SLR-Plus stem (Smith and Nephew, UK) was introduced as a design modification of the uncemented SL-Plus stem to provide enhanced load transfer from the proximal to the distal femur [4]. It basically is a longer version of the primary SL-Plus [5] stem featuring a rectangular cross section for primary stability in the affected and unaffected areas of the diaphysis. Although there are several studies using the standard stem in old patients almost no results have been published for the revision type of stem in octogenarians. We have been using these implants for years in the majority of our revision cases regardless of the patient's age. The objectives of our study were to evaluate survivorship, osseointegration and stability of the SLR-Plus stem in THA revisions for aseptic loosening in patients over 75 years old after a minimum of five years follow-up.

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Patients and methods

We retrospectively reviewed 77 patients (with 77 failed hips; 40 female and 37 male patients) who underwent revision total hip arthroplasty for aseptic loosening between 2000 and 2005. The patients had a mean age of 82.2 years (range, 75–92 years) at the time of revision surgery. The mean interval from primary THA to revision surgery was 10.9 years (range, 6.7–17 years). The indication for stem revision was aseptic loosening in all 77 hips. Both femoral and acetabular components were revised in 47 hips, in the remaining 30 cases only the stem was revised.

In all cases the SLR-Plus stem, having a grit-blasted surface with a surface roughness of 5 microns and a dual-tapered, rectangular cross-sectional shape, was implanted. It is available in nine sizes with lengths ranging from 181 to 227 mm.

The extent and location of femoral osteolysis were evaluated for all patients on radiographs. Preoperative bony defects were categorised according to the Paprosky [6] classification system: Type I, 20 hips; Type II, 40 hips; Type IIIa, 17 hips.

We used the transgluteal approach and routinely obtained Gram stains and cultures in all cases. Extended trochanteric osteotomies were performed in nine hips, and anterior fenestrations [4] for cement and cement stopper removal were done in 13 cases. Bone grafting was not involved in any procedure. Before inserting the implant specific rasps any pedestal formation was removed by intramedullary reamers. When the rasp stopped advancing it was manually tested for rotational stability. A trial component was then implanted and the hip was reduced. If the implanted trial component showed insufficient rotational stability or its explantation showed insufficient press fit fixation the next bigger size was chosen. A stem size 4 was used in 33, size 5 in 21, size 6 in ten, size 7 in eight and size 3 in five cases respectively. Cemented stems were retrieved from 27 hips, uncemented stems from 50 hips. The bearing couples were metal on polyethylene in 24 hips, metal on metal in 15 hips, ceramic on ceramic in three hips, and ceramic on polyethylene in 35 hips. All patients received identical antibiotics and prophylaxis for thromboembolism.

All patients were allowed partial weight bearing for six weeks and gradually progressed to full weight bearing by three months.

The follow-up protocols included radiographic and clinical evaluations at six weeks and at three and six months after surgery, and then annually thereafter (Figs. 1, 2, 3). At the final follow-up examination, clinical outcomes (Merle d'Aubigne [7] and Harris Hip Score [8]) and complications were assessed.

We measured stem axial subsidence using bone-prosthesis landmarks on comparison radiographs [3]; the distance between the lesser trochanter and the tip of the prosthesis was used for most patients. Osteolytic areas and radiolucencies adjacent to the stem were recorded in Gruen zones [9]. Stress shielding around the stem was assessed according to the Engh classification [10]. Definite radiographic loosening of the stem was defined as axial subsidence more than 2 mm, varus inclination of the stem of more than 3° or continuous new radiolucent lines developing around the proximal two thirds of the implant.

Fig. 1 Female patient (79 years) presenting with osteolysis around a cemented stem 13 years after implantation (X-ray of the right hip obtained in January 2001)

Results

The mean follow-up after the revision was 7.1 years (range, 5.0–10.2 years). During the minimum follow-up period of five years 11 patients died of causes unrelated to the total hip arthroplasty leaving 66 revised hips for evaluation after a minimum follow-up period of five years.

Fig. 2 Same patient as in Fig. 1 three months after revision (May 2001). The anterior window for cement removal was reinforced with one titanium cerclage. Only the tip of the revision implant is in contact with intact bone

Fig. 3 Same patient as in Fig. 1 seven years after revision (February 2008). The majority of the formerly compromised, osteolytic bone has remodelled and built up around the revision component depicting full osteointegration

Clinical results with the Merle D'Aubigne [7] scores showed that pain improved from a mean of 2.24 (range, 1–4) to 5.56 (range, 5–6), function improved from 3.49 (range, 3–5) to 5.44 (range, 4–6), and mobility improved from 2.93 (range, 1–5) to 5.87 (range, 5–6). Clinical results using the Harris hip score [8] improved from a mean of 35.9 (range, 20–65) preoperatively to 94.3 (range, 82–100) at the final follow-up.

No hips developed infection, osteolysis, subsidence or stress shielding around the stem during the follow-up period. Hip dislocation was observed in three hips managed by closed reduction and bracing. Stem fixation failed in three hips three to four years after revision; the re-revision was done by stem exchange to a larger SLR Plus stem in two cases and to a modular revision stem in one case.

Postoperative radiolucent lines were mainly seen proximally in Gruen [9] zones1 and 7 (Table 1).

In five hips (6%) intraoperative bone fissures were encountered and treated with titanium cerclage wiring (CCG system, Intraplant, Austria) [11]. Additional procedures were not required for the treatment of these fissure lines.

Discussion

The number of revision THAs performed each year has continued to rise in conjunction with the increasing frequency of primary THA [1, 3]. In addition, increases in

Table 1 Radiolucent lines at a mean follow-up of 7.1 years according to Gruen [9], depicting radiolucency mainly confined to zones 1 and 7

Zone	Percentage	Zone	Percentage
1	15%	8	12%
2	3%	9	3%
3	0%	10	0%
4	0%	11	0%
5	0%	12	0%
6	0%	13	0%
7	15%	14	12%

revision THA are due to longer life expectancy and a more active lifestyle than was once common in the elderly population. Cemented prostheses used in revision THA for femoral loosening often fail despite the development of newer cementing techniques, owing to the difficulty in achieving macrointerlocking of polymethylmethacrylate with cancellous bone [3, 12].

Holt et al. [13] stated that the cement-in-cement revision technique yielded good results with durable fixation and a low failure rate in the short/medium term. According to this review, impaction grafting of the femur has also been demonstrated to be an effective means of restoring bone stock during femoral revision.

Nevertheless, cementless femoral components have become the prostheses of choice in femoral revision THA [1–3, 14–21].

Concerns about revision THA in elderly patients include difficulty in achieving the initial stability because of thin, fragile cortices and an enlarged medullary cavity with altered femoral morphology; unreliable ongrowth from the osteoporotic diaphyseal bone to the implant surface; and a potential risk of intraoperative fracture.

Revision total hip arthroplasty in the very elderly has been shown to have functional outcomes comparable with those in younger cohorts, but the prevalence of complications in the very elderly has been reported to be higher. However, these results were obtained from studies of relatively small populations that included patients in which the revision was performed with mostly cemented components [22].

Parvizi et al. [22] reported on 170 total hip revisions performed in 159 patients with a mean age of 83.8 years (range, 80.0–93.8 years). The average follow-up was 6.8 years (range, three days to 14.7 years). Compared to a control group of patients being 70 years and younger orthopaedic complications occurred in 38 hips (22.4%) in the octogenarian group compared with 37 (21.8%) in the control group. The rate of intraoperative fracture was significantly higher in the octogenarian group (eight hips) than in the control group (no hips).

Recently, Chang et al. [3] reported on 48 total hip arthroplasty revisions with the SLR Plus stem in patients up to 80 years old (mean 66.5 years) and presented a survivorship of 98% at an average follow-up of 5.6 years. In [3] five (10.4%) cases periprosthetic fractures during surgery were encountered compared to five (6%) bone fissures in our group of patients. The stems in our patients did not show subsidence or loosening during the follow-up period; this can be explained by the primary stable fixation of the implant despite the fissure lines.

Korrovessis et al. [1] reviewed 69 selected patients (70 hips) who underwent revision of the femoral component using the SLR-Plus stem during a ten-year period in patients with a mean age of 69 years (range, 42–89 years). The indications for revision included aseptic and septic failure of biological fixation, incorrect implantation, and periprosthetic fracture. Seven patients died and four were lost to follow-up. Four stems (7%) were rerevised. With rerevision for aseptic reasons, the survival at ten years was 95%.

Considering the presence of osteoporotic conditions in the elderly, the outcome in our series is in contrast to that for extensively porous-coated and modular stems, which have a higher rate of fracture (9–30%) in revision THA [23].

Extensively coated stems have their own limitations, including extensive stress shielding, not found with other stems [3, 17]. Modular stems have less initial stability, occasional problems of fretting with micromotion or corrosion at the modular junction, leading to particle formation and osteolysis [3], and increased risk of fracture, subsidence, and dislocation (19%) [18]. Subsidence has been a concern in cone prostheses, ranging from 3.2 to 6.1 mm, with subsidence of more than 10 mm occurring in 16–19% of cases [3, 19, 20].

Mertl et al. [21] reviewed 725 revisions using seven different interlocking stems in aseptic loosenings as well as in fractures. Radiologically, 637 implants were stable, and 40 demonstrated subsidence, overall 48 implants had been revised. However, this group of patients and the stem systems used are hardly comparable to our group because the authors only present aseptic loosenings revised with a straight, tapered stem.

The stem we used achieves its stability by a linear cortical contact along its four corners. Fixation of this stem does not depend on filling, as it does in extensively coated cylindrical or the modular stems. Initial stability is also considered most critical in achieving long-term bone ingrowth, which can be reliably achieved with this stem design. As the instruments for bone preparation are constructed as longitudinal acting rasps the need for diaphyseal reaming for femoral preparation is obviated thus avoiding inadvertent perforation and heat damage to the bone. The advantage of the rasping procedure can also be seen in the generation of small bone particles which can act as autologous bone transplants ("Cutting-Grinding" effect) according to Lintner et al. [24]. Rinsing of the medullary canal after preparation should therefore be avoided.

At an average of 7.1 years (range, five to ten years) the stem survival rate for our patients being 75 years (mean 82.2 years) and older at time of revision surgery was 95.5%. We encountered three aseptic loosenings three to four years after revision.

In conclusion, the press-fit and rectangular cross-sectional stem (SLR-Plus) is useful and safe for revision THA in elderly patients because of the favourable clinical and radiological outcome, independent of the morphological shape of the femur and bone quality. However, the current SLR-Plus stem model is not indicated when bone deficiency extends to the distal femur, as in IIIb and IV defect situations, according to Paprosky [6]. Further studies of this stem with long-term follow-up monitoring are mandatory.

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